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U. S. DEPARTMENT OF  
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SOYBEAN  
HAY AND SEED  
PRODUCTION



**S**OYBEANS have gained rapidly in importance as a hay and seed crop during the last decade.

Increased acreage and greater utilization of the crop have brought about more efficient methods and the use of new or improved machinery.

Soybeans are best fitted for hay when the seeds are about one-half developed.

Soybean hay is but little more difficult to cure than hay from other legumes and may be handled successfully by about the same methods.

Soybean hay requires thorough curing before being stacked, housed, or baled, as danger of molding occurs when the hay is stored or baled too green or too soon after a rain.

Tentative United States standards have been prepared to provide a definite basis of quality for use in the marketing of soybean and soybean mixed hay.

Unless a special harvester or combine is used, soybeans should be cut for seed when the seed is in the hard-dough stage.

The most successful means of harvesting the seed include the grain binder, the mower, the self-rake reaper, special row and broadcast bean harvesters, and the combine.

The ordinary grain separator can be adjusted to thresh soybeans without cracking or splitting them. Special bean and pea separators are extensively used.

Machines constructed especially for harvesting soybeans are used in some sections.

Several types of combines are being extensively used in the large seed-producing sections.

Soybean seed should be thoroughly dried before storing. Only under exceptional conditions is soybean seed attacked by weevils.

United States standards are now used extensively for grading and marketing soybean seed.

This bulletin supersedes Farmers' Bulletin 886, Harvesting Soy-Bean Seed.

# SOYBEAN HAY AND SEED PRODUCTION

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## INTRODUCTION

THE SOYBEAN has gained rapidly in importance as a hay and seed crop during the last decade and seems to have found a permanent place in many farming systems of the eastern half of the United States. The development of more economical methods and suitable machinery in harvesting and handling the crop has been one of the most serious problems of successful production. The methods employed in the production of soybean hay and seed vary with the types of farming practices in those States growing large acreages of the crop, and increased acreage and greater utilization of the soybean have brought about more efficient methods and new or improved machinery. Many types of machines, ranging from the single-row harvesters to the combine used in the harvesting of small grains, are now available for the more economical production of seed. Perhaps no greater advance has been made in any farm practice than in the harvesting of the soybean crop.

## SOYBEAN HAY PRODUCTION

The soybean is not a difficult crop to grow for hay, and when cut at the proper stage of growth and properly cured it makes excellent hay of high feeding value. An annual legume widely adapted to various soils, the soybean can be used in any rotation and is grown successfully on soils too acid to grow red clover, sweet clover, or alfalfa. It is not to be considered as a competitor of clover or alfalfa in regions suitable to these crops, but rather as a supplement and addition to them. In case of the failure of an old or new clover or alfalfa seeding, winter grain, or a spring crop, there is ample time to grow a crop of soybeans for hay. Soybeans are also excellent as a summer catch crop following early crops or in fields not in the regular rotation.

## TIME OF CUTTING

The soybean may be cut for hay at any time from the forming of the pods until the seeds are three-fourths grown. The crop is best fitted for hay, however, when the seeds are about half developed, and it is at this stage that the best quality of hay may be obtained. If the crop is cut earlier, the percentage of protein will be higher, but the total yield will not be so large, and the difficulty of curing will be much greater. If the cutting is delayed, however, the stems rapidly become hard and woody, and if left too long much loss in leaves will occur, thus decreasing the palatability and the feeding value. Table 1 shows the variations in the composition of hay of the Peking variety harvested at different stages of development.

TABLE 1.—*Composition of soybean hay of the Peking variety at different stages of development*

Stage of growth	Constituents (per cent)					
	Moisture	Protein	Fat	Nitrogen-free extract	Fiber	Ash
Full bloom.....	5.33	17.09	1.45	34.60	23.31	18.22
Pods forming.....	5.28	19.31	1.87	35.66	26.49	11.39
Beans half developed.....	5.04	16.59	3.02	36.28	26.30	12.77
Beans fully developed.....	5.29	16.84	8.79	34.93	25.13	9.06

## METHOD OF CUTTING

Various methods of cutting the soybean crop for hay have been practiced, but the mowing machine is the implement most generally used. The self-rake reaper is used successfully in many sections in cutting the crop for hay, for soilage, and for silage; the binder is also used in some sections in cutting for hay and silage. Soybean plants contain a rather high percentage of moisture, and when cut for hay with the binder, unless the bundles are loosely bound, there is danger in damp weather of some loss from molding in the center of the bundles.

## CURING SOYBEANS FOR HAY

Some experience is necessary in curing soybean hay, as it is more difficult to cure than alfalfa or clover, but it may be handled by about the same methods. Greater difficulty will be experienced in curing the hay of late varieties than that of varieties reaching full maturity in the given locality. The stems of soybeans cure slowly; consequently, special attention is required to save the leaves, which, as with all legume hays, are the most valuable part.

The methods to be used will vary in different sections, but hay of good appearance and quality can generally be made if the producer is careful. Soybean hay is not injured by wet weather to as great an extent as are other legume hays. Weathered soybean hay, although probably not as nutritious as well-cured hay, is of good feeding value and is readily eaten by livestock.

The most common method employed is to cut the crop as soon as the dew is off the plants and leave it in the swath until thoroughly

wilted. After wilting and before the leaves become dry and brittle the hay is raked into windrows and left a day or two, depending on the weather, and then placed in tall narrow cocks or bunches to complete the curing. After four or five days of fair weather, soybean hay is ready to be stacked or housed. The bunches or cocks should be opened a few hours before hauling to dry out thoroughly.

The curing of soybean hay entirely in the swath is practiced in many sections. The crop is cut with the mower and left to lie until entirely cured. The hay is then raked either on a cloudy day, in the evening, or in the morning when the dew is on. Although the crop is cured more rapidly by this method, the hay is more subject to



FIGURE 1.—Soybean hay after curing in the swath or windrow may be taken up with the drum hay loader

bleaching in case of prolonged wet weather and to greater loss of beans and leaves. When cured in the swath the hay may be raked with a side-delivery rake and taken up with the hay loader. (Fig. 1.)

Another method successfully used is to allow the crop to lie in the swath for a day or two and then rake into windrows to complete curing. Usually it will be found necessary to turn the windrows. Hay of a better color than that cured by the swath method is thus obtained, but in rainy weather the windrows are hard to dry out, more handling is required, and the result is a greater loss of leaves and beans.

The use of curing frames or poles (fig. 2) is very generally practiced in the Southern States and to some extent in other sections

under unfavorable weather conditions. Although the hay, as a rule, should be well wilted when placed on a frame or pole, well-cured hay may be obtained by placing the crop on the frames or poles as soon as cut.

Soybean hay should be thoroughly cured before it is stacked, housed, or baled. There is danger of molding when the hay is stored or baled too green or too soon after a rain. When left in the open, the hay should be placed in good-sized stacks and grass or some other material that sheds rain placed over each stack. Placing poles or logs in the center of the stack so as to provide air passages will greatly lessen the danger of spoiling. Molding also may be avoided by alternating a layer of soybean hay in the stack or mow with a layer of straw.



FIGURE 2.—The use of curing frames is very generally practiced in the Southern States

#### BALING THE HAY

The baling of soybean hay has increased to a very considerable extent in many sections of the Southern and Corn Belt States. Although the hay is often baled directly from the windrow or from the cocks, the practice is not a desirable one in humid regions. The most serious difficulty is that hay from the field is often baled too soon. It may appear to be sufficiently cured, but upon examination it will be found that only the leaves are dry enough, while the stems and pods are still sappy. If such hay is baled, it will go through the process of sweating, and a damaged hay of poor quality will result. In baling soybean hay from the field the hay should be thoroughly cured. A test that will indicate to a certain extent the fitness of the hay for baling is to try a handful of hay by twisting it in the hands. If it breaks easily when twisted once or twice, it is well cured; but if it is hard to break and sap is squeezed out of the stems or pods, it is not in condition to be baled. After soybean hay has been stacked or housed, a process of sweating takes place, requiring four to eight

weeks, after which there is practically no danger of heating in the bale.

#### YIELDS OF HAY

Soybeans will yield from 1 to 3 tons of hay to the acre, and occasionally 4 to 5, depending upon the fertility of the soil and the season. Good forage varieties under favorable conditions should average at least 2 tons to the acre. In the Southern States the late-forage varieties of the Ootootan, Barchet, and Laredo types under favorable soil and seasonal conditions average 4 or more tons to the acre.

#### SOYBEAN HAY GRADES

Tentative United States standards<sup>1</sup> have been prepared by the Bureau of Agricultural Economics, United States Department of Agriculture, to provide a definite basis of quality for use in the marketing of soybean and soybean mixed hay. Although the present production of soybean hay for marketing is not large, uniform standards undoubtedly will aid materially in stabilizing the industry, in promoting better production and curing methods, and in developing more extensive marketing of soybean hay in regions of surplus production.

#### SOYBEAN SEED PRODUCTION

The more extensive use of the soybean for pasturage, forage, and in the manufacture of oil and soybean meal and food products has resulted in an enormous increase in acreage and production of seed. The soybean is a profitable crop when grown for seed purposes, and the seed-growing industry has developed extensively in many sections of the Corn Belt and Cotton Belt States.

The character of growth, uniform maturing habit, and heavy seed yields contribute to the ease of harvesting and recommend the plant for seed production. When soybeans are grown for beans alone, shattering is a serious fault, and inexperienced growers are likely to sustain heavy loss through lack of knowledge and improper handling of the crop.

All soybeans are strictly determinate as to growth; that is, the plants reach a definite size, according to variety and environment, and then mature and die. If not harvested at the proper stage of maturity, nearly all varieties shatter their seed somewhat, especially during changeable weather. Special attention, therefore, is required when the plants approach maturity to prevent serious losses from shattering. Some varieties shatter very badly and others, such as the Biloxi, Manchú, and Mansoy, scarcely at all.

The harvesting of seed has been one of the most difficult problems in the development of the industry. Until the advent of the combine and special harvesters and threshers, growers of soybeans had to use the machinery at hand, with more or less unsatisfactory results. Improved methods and machinery for handling the seed crop tend to assure greater agricultural development of the soybean in America.

<sup>1</sup> UNITED STATES DEPARTMENT OF AGRICULTURE. BUREAU OF AGRICULTURAL ECONOMICS. TENTATIVE UNITED STATES STANDARDS FOR SOY-BEAN AND SOY-BEAN MIXED HAY. 2 p. [1928.] [Minreographed.]



## TIME OF HARVESTING

When the soybean plant approaches maturity, the leaves begin to turn yellow and drop; and before all of the pods are fully mature the leaves, except in a few varieties, have fallen. In general, the best time to harvest, except when a special bean harvester or combine is used, is when the pods are fully mature and the seed is in the hard-dough stage. If cut at an earlier stage, the plants cure more slowly, the yield of seed is lessened materially, and an inferior quality of seed results. On the other hand, if the seed is allowed to become fully mature, there is unnecessary loss from shattering. If, however, the crop has been allowed to reach full maturity, this loss from shattering can be prevented by cutting the plants in the morning, when they are damp. Varieties that do not shatter easily may be allowed to stand until fully mature.

When special bean harvesters and the combine harvester and thresher are used it is necessary for the seed to reach full maturity to obtain the best results. The time of harvesting will vary somewhat with weather conditions. In a hot, dry fall greater care should be taken in the harvesting of varieties tending to shatter. A few varieties of the nonshattering type can be left until fully mature in almost any kind of season with little or no loss of seed.

Growers with little experience often attempt to obtain hay as well as seed from the same crop, but there is no stage at which the soybean can be cut for hay and seed at the same time if quality and yield are to be considered. For the best quality of hay the crop should be cut three to four weeks before it would be harvested for a high quality of seed.

## METHODS OF HARVESTING

In the different sections where the soybean is grown largely for seed production, various methods of harvesting are used. The most successful of these methods include the grain binder, the mower, with and without a side-delivery attachment, the self-rake reaper, special row and broadcast bean harvesters, and the combine.

When the cutting is done with a mowing machine, it is well to have a side-delivery attachment, as with this attachment the horses and mower wheels will not travel on the swath of cut beans and cause unnecessary shattering and loss of seed. If cut with a mower without such an attachment, however, the plants should be moved out of the way of the team at every round, or the crop should be cut while damp or at a little earlier stage of maturity.

With the taller growing varieties, if the plants are not too coarse and too mature, the grain binder is rather widely used to good advantage. For the best results the crop should be cut before all of the leaves have fallen or when damp, as the plants will cut more easily and less loss will result from shattering. The bundles should be comparatively small, loosely bound, set up in small shocks, and allowed to cure in the field. This method is especially valuable when winter wheat follows soybeans in the rotation. The wheat drill may follow immediately behind the binder, and with the bundles of beans falling on the drilled land there is no interference in the sowing of the wheat.

The self-rake reaper (fig. 3) has given very satisfactory results, as the plants are placed in bunches out of the way of the machine and the horses, and may be left to cure as they are, or they may be placed in small loose cocks.

Varieties of the Wilson, Virginia, Laredo, and Ootootan types frequently tend to lodge badly in very fertile soils. If the crop has lodged to any considerable extent, harvesting becomes a rather difficult task. Extension guards bolted to the sickle bar will aid in picking up the lodged plants and will make the harvesting much more efficient.

#### METHODS OF CURING AND HANDLING

When cut with a mowing machine with an attachment or with a self-rake reaper, the plants may be placed in small cocks. These piles or cocks should be left for four or five days in good drying



FIGURE 3.—The self-rake reaper which has given very satisfactory results in cutting soybeans for seed

weather or until the beans are found to be fairly dry in the pods. Wet weather does not seriously injure the crop, provided the plants are not allowed to rest on the ground for any length of time. If rain occurs, the piles should be watched carefully and turned frequently. In the handling of the crop, during or after curing, the plants must be tough from dew or rain to prevent loss from shattering.

Where a binder is used, the bound bundles should be shocked 8 or 10 to a shock (fig. 4) and allowed to remain until thoroughly dry.

Hay caps are not necessary when the piles or bundles are properly shocked, and the shocks may be left in the field until threshing time, or, if then thoroughly dry, they may be housed or stacked and threshed later. If the time of threshing is indefinite and if it is necessary to remove the crop from the field after curing and if housing space is not available, the crop can be stacked with excellent success. Soybeans are stacked in much the same way as small grains.

## METHODS OF THRESHING

The ordinary grain separator (fig. 5) can be adjusted to thresh soybeans successfully, but if used as equipped for small grains it will crack a large percentage of the beans. The chief cause of split beans is the high speed of the cylinder, which should be reduced to approximately one-half to one-third of the normal threshing rate. The other parts of the separator should be maintained, however, at normal speed, and this may be accomplished by doubling the size of both cylinder pulleys. If the beans are dry, no concave teeth are necessary; a board may replace the blank concave. If the pods are tough, a special set of thin concaves may be used, or most of the concave teeth may be removed. Good judgment on the part of the operator will enable him to adjust the ordinary separator so that the



FIGURE 4.—When cut with a binder, the bundles of soybeans should be shocked and allowed to remain in the field until thoroughly cured

beans may be threshed with little splitting. Some manufacturers have special pea and bean hulling attachments for grain separators, and these do very satisfactory work. These attachments may be added to the ordinary separator at small cost.

Pea and bean separators of different sizes are used in many of the soybean-producing sections. These machines do clean hulling and split practically none of the beans. They are more satisfactory and economical where a considerable acreage of soybeans is grown.

In some sections the corn shredder has been used to advantage, and if the beans have been properly cured and dried they shell out very readily with this machine.

Soybeans if thoroughly dry can easily be threshed with a flail. If only a small acreage is involved, this method is practicable and economical.

## SPECIAL HARVESTING AND THRESHING MACHINES

In the Southern States, where the soybean is grown extensively, the harvesting from mature standing vines by special harvesters, of which there are several types, has become quite common. The commonest type is a 2-wheeled boxlike machine (in some instances improved by a cleaning attachment), drawn by two horses. (Fig. 6.) As the machine passes over the row, four sets of rapidly revolving rods or long teeth on a large cylinder shatter or beat the beans from the pods into the body of the harvester. As the machine moves up the row, the harvested seed is raked by hand to the rear of the box. When the box is filled, the seed is removed and the pods and trash screened out. Under favorable conditions, two men with a team can harvest 5 or 6 acres a day, and although there is some



FIGURE 5.—The ordinary grain separator can be adjusted to thresh soybeans successfully

loss of beans, this loss is compensated for in most cases by the saving of time and labor. These machines are best adapted to harvesting varieties of the bush type grown in rows 32 to 42 inches apart, although one type of harvester is suitable for harvesting beans drilled in close rows. With vining varieties only fair work can be expected, and that only where the plants are not lodged too badly. If the growth is rank and lodged to any extent, the best results will be obtained by making two trips in opposite directions over the row.

Soybeans have been harvested and threshed successfully with combines.<sup>2</sup> (Fig. 7.) Several types of combines are now used extensively in the large soybean-producing sections of the Corn Belt States. All of these machines work on the same general principle; that is, they cut the mature plants and elevate them to the cylinder, where

<sup>2</sup> REYNOLDSON, L. A., MARTIN, J. H., and HUMPHRIES, W. R. SHALL I BUY A COMBINE? U. S. Dept. Agr. Farmers' Bul. 1565, 18 p., illus. 1928.

the beans are threshed out. After passing over the screens and through the air blast as in an ordinary thresher, the beans are carried to a bin on the machine and then run directly into a wagon at the side of the combine or run into sacks which are tied and dropped from the machine. The straw is carried to the rear of the machine, where it may be distributed over the field by a straw spreader, or if desired for feeding or bedding, it may be placed in windrows for later gathering.

To prevent the beans from splitting when harvested with the combine, the speed of the cylinder, as with the ordinary separator, should be about half the speed used for harvesting wheat. The separating unit of the machine should be kept at the same speed as with wheat to insure proper cleaning and quick disposal of the threshed material. No concave teeth are necessary if the crop is uniformly mature, but if the beans are not thoroughly ripe, concaves are needed to insure clean separation.

The advantages of using the combine as compared with other methods of harvesting and threshing soybeans are the saving of labor



FIGURE 6.—A special soybean harvester used to gather soybean seed from the standing mature plants

and the reduction of harvesting costs, reduction in loss of beans, early clearing of fields for tillage operations, distribution of the straw on the land, and earlier marketing of the beans. Moreover, beans on standing plants are not so likely to be injured by bad weather as those harvested by ordinary methods and left in the field to be threshed later. The principal objections to using the combine are the large investment required and the difficulty of saving the straw, which might be used for feeding.

#### PROPORTION OF STRAW TO SEED

The proportion of soybean straw to a bushel of seed varies widely according to variety. In general, the varieties giving the highest seed yields have a comparatively low proportion of straw to seed. Data obtained from 5-year average yields of seed and straw by the Ohio Agricultural Experiment Station<sup>3</sup> are shown in Table 2.

<sup>3</sup> WILLIAMS, C. G., and PARK, J. B. SOYBEANS: THEIR CULTURE AND USE. Ohio Agr. Expt. Sta. Bul. 312, p. 581-600, illus. 1917.

TABLE 2.—*Relative yields of straw to seed in different varieties of soybeans*

Variety	Yield per acre, 5-year average		Weight of straw per bushel of seed	Ratio of straw to seed
	Seed	Straw		
	<i>Bushels</i>	<i>Pounds</i>	<i>Pounds</i>	
Cloud.....	18.34	2,510	137	1 : 2.3
Ebony.....	23.78	2,166	91	1 : 1.5
Elton.....	26.51	1,906	72	1 : 1.3
Habaro.....	23.70	2,134	90	1 : 1.5
Hamilton.....	23.49	2,636	112	1 : 1.8
Ito San.....	21.17	1,956	92	1 : 1.5
Medium Green.....	23.87	2,185	91	1 : 1.5
Midwest.....	24.06	2,278	95	1 : 1.6
Mikado.....	19.85	2,114	106	1 : 1.7
Peking.....	14.01	2,292	164	1 : 2.7

## YIELDS OF SOYBEANS

The best producing varieties of soybeans, when grown alone for beans under proper culture and favorable conditions, yield from 25 to 40 bushels (60 pounds per bushel) to the acre. Yields, however, in

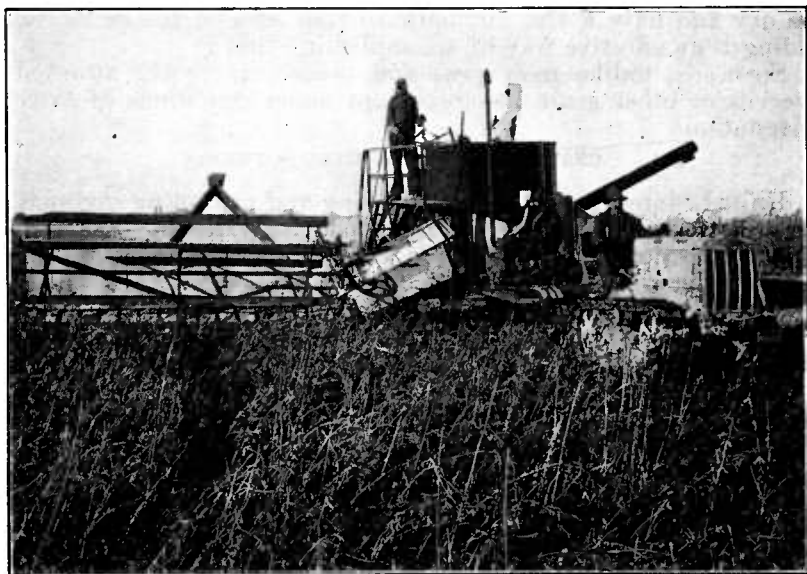


FIGURE 7.—Soybeans are harvested and threshed successfully with combines

different sections range from 15 to 25 bushels in the Northern and Central States and from 15 to 35 or more bushels in the Southern States. Maximum yields of 50 or more bushels to the acre have been reported from North Carolina and Tennessee. Yields of the same variety vary greatly in different sections, which may be attributed in many cases to the adaptability of the variety to certain localities. In addition to varietal adaptability, yields also vary with methods of culture, seasonal conditions, soil, and climatic adaptations.

## STORAGE OF SOYBEANS

As soybeans spoil rather easily if not properly handled, care should be exercised in curing and storing. After threshing, the beans should be watched carefully to avoid heating and molding. Heating is especially liable to occur if the seed is bulked in large quantities in a bin or a poorly ventilated room, and this is almost certain to result if the beans are not fully dry when threshed. When the beans are thoroughly dry there is little danger of heating. In Manchuria soybeans are thoroughly dried and then placed in sacks, which are built up in large ricks and covered with matting. The maximum percentage of moisture with which soybeans may be stored safely has not been definitely determined. However, when the beans are sound, well matured, and practically free from foreign material they have not been found to go out of condition when stored, either in sacks or in bins, with 16 per cent moisture. If the beans are to be used for seeding purposes or if they are immature or contain a high percentage of damaged beans and foreign material, they should be permitted to dry out more thoroughly by spreading them on a floor immediately after threshing and turning them over from time to time before putting them in sacks or bins. The storeroom should be dry and have a free circulation of air around the sacks. Cross piling is an effective way of accomplishing this.

Soybeans, unlike most peas and beans, are rarely attacked by weevils or other grain insects, except under conditions of excessive infestation.

## GRADING AND MARKETING SOYBEANS

United States standards<sup>4</sup> for grading and marketing soybeans are now used extensively in the large producing sections. Federal soybean inspection is authorized by a clause in the annual appropriation act for the Department of Agriculture. The general plan for conducting this service provides for the employment of soybean inspectors at shipping points and at important terminal markets under cooperative agreements between the Bureau of Agricultural Economics and organizations such as State departments of agriculture, commercial exchanges, and dealers' or growers' associations. Any person who has a financial interest in a lot of soybeans and who desires to obtain inspection of the lot should make application for inspection to any Federal soybean inspector. The application for this service may be made also direct to the Bureau of Agricultural Economics, Washington, D. C. The adoption and use of the United States standards by all agencies engaged in handling soybeans should promote uniform grading and facilitate the marketing of the commodity.

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<sup>4</sup>UNITED STATES DEPARTMENT OF AGRICULTURE. BUREAU OF AGRICULTURAL ECONOMICS. HANDBOOK OF UNITED STATES STANDARDS FOR SOYBEANS. U. S. Dept. Agr., Bur. Econ. Form HSF-899, 20 p., illus. 1928.

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October 5, 1929

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